

ULTRANANOCRYSTALLINE DIAMOND (UNCD®) MECHANICAL SEALS

APPLICATIONS

- Petroleum and chemical industries
- Pharmaceutical industry
- Pulp and paper industry
- Power Generation
- Food and beverage industry
- Mining and minerals
- Transportation
- Semiconductor industry
- Water and waste industry
- Refrigeration industry
- Automotive and appliance industries

BENEFITS

- Cost Effective
- Energy savings by greatly reducing friction at the sealing interface
- Promote longevity of seal faces
- Cuts maintenance costs by improving tolerance to poorly lubricated conditions
- Enables pumping or thermally sensitive media

STATUS

- Winner, 2008, R&D Award
- Commercialization is under way

Breakthrough Technology Benefits Pump Industry

Overview

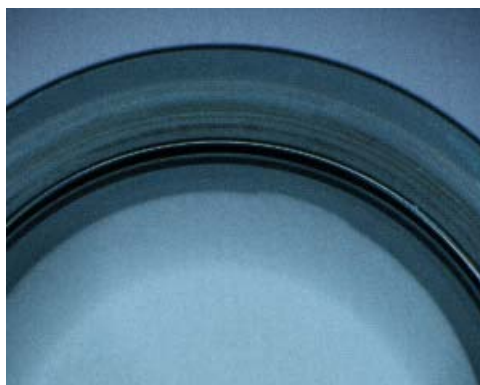
High-performance centrifugal pumps form the backbone of modern industry because they can transfer a great variety of fluids and slurries with high efficiency over a wide range of flows and pressures. Crucial to pump operation are the mechanical seals that prevent the fluids being pumped from escaping into the environment while pumping proceeds. In fact, the number one cause of pump downtime is shaft seal failure. To overcome that problem, Argonne researchers have developed and patented a breakthrough technology: Ultrananocrystalline Diamond (UNCD) mechanical seals.

Argonne's UNCD mechanical seals are primarily designed for high-performance centrifugal pumps. The technology is significant because the UNCD seals

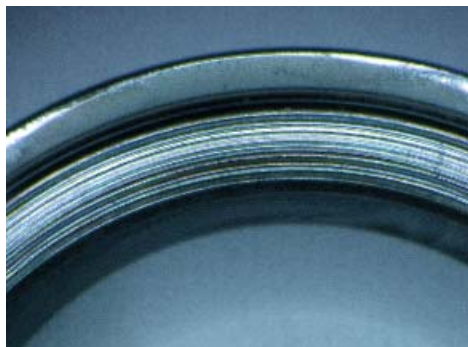
harness the unsurpassed properties of diamond to improve the reliability, useful life, and integrity of fluid sealing systems. UNCD is also suitable for use with centrifugal gas compressors.

Diamondlike Properties, Performance

UNCD is a nanomaterial consisting of diamond grains only 2–5 nm in size (20 carbon atom diameters), separated by grain boundaries that are atomically abrupt. The grain boundaries consist of a mixture of diamond- and graphite-bonded carbon. Thus, UNCD is not pure diamond but a nanostructured hybrid of different carbon allotropes (i.e., different forms of the same substance — in this case, carbon) that retains most of the desirable extreme properties of diamond — and, in some cases, exceeds the properties of natural diamond (e.g., fracture strength, electrical transport, field-induced electron emission, electrochemistry, and bio-inertness). Argonne's patented UNCD films have been proven to provide ideal mechanical seal faces precisely because such films



UNCD seal face shows almost no wear after running for 100 h in 250°F water at 100 psig.



Silicon carbide seal face shows deep grooves after running for 100 h in 250°F water at 100 psig.

LINKS TO ONLINE INFORMATION

[http://www.anl.gov/techtransfer/
Available_Technologies/
Material_Science/index.html](http://www.anl.gov/techtransfer/Available_Technologies/Material_Science/index.html)

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ABOUT ARGONNE TECHNOLOGY TRANSFER

Argonne National Laboratory is committed to developing and transferring new technologies that meet industry's goals of improving energy efficiency, reducing wastes and pollution, lowering production costs, and improving productivity. Argonne's industrial research program, comprised of leading-edge materials research, cost-saving modeling, and unique testing and analysis facilities, is providing solutions to the challenges that face U.S. manufacturing and processing industries.

Diamondlike Properties, Performance (continued)

retain the superior hardness, chemical inertness, and ultralow friction characteristics of natural diamond.

Technology Meets Critical Industry Need

Centrifugal pumps are used for extreme condition service in the petroleum, chemicals, pharmaceutical, pulp and paper, power generation, food and beverage, mining and minerals, transportation, semiconductor, water and waste, refrigeration, automotive, and appliance industries. They are used in virtually every industrial setting because they can transfer a great variety of fluids and slurries with high efficiency over a wide range of flows and pressures. Inevitably, they are critical elements of industrial processes wherever they are used, in that whenever centrifugal pumps shut down for maintenance or repair, the processes they serve must also shut down, impacting productivity and therefore profits.

Regardless of industrial setting, Argonne's UNCD mechanical seals are designed to meet demanding industrial requirements involving aqueous solutions, chemicals, corrosive liquids, high-pressure liquids, and hydrocarbons and solvents.

Cost-Effective, Rapid Payback

Mechanical seals come in hundreds of varieties and sizes for myriad applications, ranging from pumping steam to petroleum fluids to abrasive slurries. UNCD mechanical seals are competitively priced with respect to the silicon carbide seals they replace, and industry will save money in pump life cycle by switching to UNCD mechanical seals. Because UNCD can be applied relatively inexpensively, UNCD mechanical seals can offer industry immediate payback in terms of energy savings by greatly reducing friction at the sealing interface. The seals also offer greatly increased mean time to replacement because the faces last longer; increased tolerance to poorly lubricated conditions, which significantly reduces maintenance costs; and reduced face temperatures, which permits the pumping of thermally sensitive media.

Proven, Market-Ready Technology

Because of the numerous highly promising applications for UNCD thin films, Argonne transferred the technology to a start-up company, Advanced Diamond Technologies, Inc. (ADT), that would focus on the technology and pursue multiple markets. ADT has already vigorously pursued several application areas, including mechanical seals, and is doing research on several others.

One of the first steps taken in this regard was to establish a joint development agreement with John Crane, Inc., the technology leader and the world's largest manufacturer of mechanical seals and associated products. Under the agreement, John Crane performed scores of characterization tests. The results have demonstrated that UNCD dramatically improves the performance capabilities of mechanical seals. The focus is now on producing the seals in large batches so they could be manufactured affordably and utilized for improved performance in commercial applications.



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